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Examining the Interactions between Rhizome Size and Treatments on Turmeric (*Curcuma longa* L.) Cultivar GNT 2

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ABSTRACT: Examining the Interactions between Rhizome Size and Treatments on Turmeric (*Curcuma longa* L.) Cultivar GNT 2 was conducted during the *Kharif* season of 2021-22 at the Department of Seed Technology, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. The research employed a Randomized Complete Block Design with three replications and focused on the GNT 2 turmeric variety, evaluating seven different treatments and four combinations of rhizome sizes. Among these, the combination of mother rhizome (R4) and chiller treatment (T4) at 4°C for 2 hours demonstrated the highest values for various traits, including germination percentage (91.11%), plant height (70.29 cm), leaf length (40.14 cm), leaf width (15.22 cm), number of tillers per plant (4.07), mother rhizomes per plant (2.73), primary rhizomes per plant (8.40), secondary rhizomes per plant (10.00), rhizome length (16.63 cm), rhizome width (18.02 cm), and rhizome weight (219.48 g). Understanding and utilizing the interaction effect between rhizome size and treatments is crucial for optimizing turmeric growth and maximizing yield potential. The findings provide valuable insights for improving turmeric cultivation practices and advancing production techniques. However, implementing the precise conditions of optimal rhizome size and chiller treatment in real-world turmeric cultivation poses logistical challenges for farmers, requiring careful consideration and adaptation to practical farming scenarios.

Keywords: Chiller treatment, *Curcuma longa*, GNT 2, Mother rhizome.

INTRODUCTION

India is known as the "Spice Bowl of the World" because of its high-quality spice output. Growing spices for various uses has been practiced since antiquity (Angles *et al.*, 2011). Turmeric (*Curcuma longa* L.) is a perennial herbaceous plant belonging to the family *Zingiberaceae*. It is renowned for its extensive use in traditional medicine and has garnered significant attention in scientific research due to its active compound, curcumin. Curcumin has been extensively studied for its potential health benefits, including its anti- inflammatory, antioxidant, antimicrobial, and anticancer properties (Gupta *et al.*, 2013; Aggarwal *et al.*, 2013; Reeta and Kalia 2022). Turmeric is grown in specific niche regions and it has crop duration of 8-9 months. It is grown both as sole and mixed crop especially with coconut (Nandakumar *et al.*, 2023).

India dominates global turmeric production with an 80% share, followed by China (8%), Myanmar (4%), Nigeria (3%), and Bangladesh (3%) (Anonymous 2021[a]). Important turmeric-growing states in India include Maharashtra, Telangana, Odisha, Andhra Pradesh, Tamil Nadu, Karnataka, West Bengal, and Assam. Gujarat during 2021-22 contributes 16.83 MT from 4.28 ha (Anonymous 2021[b]). India is the largest producer, consumer and exporter, accounting for 80%, 90%, and 60% of the world total respectively.

To meet the increasing global demand for turmeric and curcumin, it is essential to optimize the cultivation practices for this valuable medicinal plant. Among the various factors that influence turmeric cultivation, the size of the rhizomes and the treatments applied to them play a crucial role (Barad and Viradiya 2023). Rhizomes serve as the underground stems from which turmeric plants grow and significantly impact the growth, development and yield of the plant. Larger rhizomes with their greater nutrient reserves, often result in more vigorous and productive plants (Kumar and Gill 2011; Mirjanaik and Vishwanath 2020).

Interaction effects between different rhizome sizes and treatments is essential in optimizing turmeric

cultivation practices. Evaluating the effect of rhizome size on the growth and development of turmeric plants can significantly impact yield (Hailemichael and Tesfaye 2008, Padmadevi *et al.,* 2012; Patel *et al.,* 2018). Turmeric plants propagate through mother rhizomes and finger rhizomes, which vary in size due to differences in development time. Determining the optimum size of seed rhizomes is necessary for maximizing turmeric cultivation (Hossain *et al*., 2005). By studying the interaction between rhizome sizes and treatments, such as soaking in growth regulators, bio-stimulants, or fungicides, we can enhance germination, control diseases, and stimulate root development in turmeric plants. The findings from this research will provide valuable insights for turmeric farmers, agronomists, and researchers, contributing to the development of sustainable and efficient cultivation practices for this economically significant crop.

MATERIALS AND METHODS

The experiment titled "Examining the Interactions between Rhizome Size and Treatments on Turmeric (*Curcuma longa* L.) Cultivar GNT 2'' was conducted during the *Kharif* season of 2021-22 at the Department of Seed Technology, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. The geographical coordinates of the location are 24° 19' 26" North Latitude and 72° 18' 53" East Longitude, with an altitude of 154.52 meters above mean sea level. The experimental design employed was a factorial randomized block design (FRBD) with three replications and a spacing of 45 x 30 cm was used. The variety used in the study was Gujarat Navsari Turmeric 2. The cultural practices were carried out following the recommended package of practices. The treatment included different sizes of rhizomes based on weight, as described in Table 1.

The collected data for various parameters were analyzed using appropriate statistical procedures recommended for randomized complete block design (Factorial) by Panse and Sukhatme (1978). The parameters analyzed included germination percentage, plant height, leaf length, leaf width, tillers per plant, mother rhizomes per plant, primary fingers per plant, secondary fingers per plant, rhizome length, rhizome width and fresh rhizome weight. The mean values of five plants were considered for the analysis.

RESULT AND DISCUSSION

The analysis of variance (mean sum of the square) for the interaction between four rhizome sizes and seven treatments for different characters is presented in Table 2.

Significant interaction effects between rhizome size and treatment were observed for all characters studied. The highest germination percentage was recorded in the R_4 (mother rhizome) and T_4 (chiller treatment) combination (91.11%). Pre-sowing chilling treatments, either used alone or in combination, were effective in reducing the gap between planting and emergence and protecting the rhizomes from biotic and abiotic stresses during the critical phase of seedling establishment, ultimately leading to an increased germination percentage.

The interaction between mother rhizome and chiller treatment showed significant effects on plant height, with R_4T_4 (70.29 cm) being comparable to R_1T_5 (67.80 cm), R_4T_7 (67.63 cm), R_4T_2 (67.03 cm), R_2T_1 (67.02 cm), R_1T_3 (65.81cm), and R_2T_7 (63.11 cm). For leaf length, R_4T_4 (40.14 cm) was at par with R_1T_5 (38.35 cm), R_4T_6 (38.29 cm), R_4T_3 (38.27 cm), and R_4T_5 (36.95 cm). Similarly, for leaf width, R_4T_4 (15.22 cm) was at par with R_1T_5 (14.25 cm) and R_4T_5 (14.10 cm). Other parameters such as the number of tillers per plant, mother rhizomes per plant, primary fingers per plant, secondary fingers per plant, rhizome length, rhizome width, and rhizome weight also showed significant interactions between different rhizome sizes and treatments (Watkinson and Pill 1998; Bandara *et al.,* 2000; Wu *et al.,* 2015; Patel *et al.,* 2018; Barad and Viradiya 2023).

Padmadevi *et al.* (2012) suggested that the maximum rhizome yield in the mother rhizome treatment could be attributed to better crop growth, including increased plant height and a higher number of leaves per plant. This resulted in increased interception of photosynthetically active radiation and ultimately led to higher crop yield. The difference in performance between mother rhizomes and finger rhizomes can be explained by the source- sink relationship, where the mother rhizome acts as a stronger sink compared to the finger rhizome. Singh (1985) observed that chilling treatments initiate a chain of biochemical events and metabolic changes in seeds, bulbs, or rhizomes, which ultimately contribute to increased yield.

Table 1: Treatment details.

Rhizome size (R)	Treatment (T)
R_1 = >35 g finger rhizome	T_1 = 4-second microwave treatment
R_2 = >20-25 g finger rhizome	T_2 = 8-second microwave treatment
R_3 = ≤ 5 g finger rhizome	T_3 = Deep freezer treatment (-20°C for 2 hrs.)
R_4 = Mother rhizome	T_4 = Chiller treatment (4°C for 2 hrs.)
	T_5 = Sodium hypochloride treatment (4% for 2 hrs.)
	T_6 = Tap water treatment for 2 hrs.
	T_7 = Control

Table 2: Influence of different rhizome size and treatments on germination and its attributes traits of turmeric cv. GNT 2.

Rhizome size × treatments	Germination(%)	Plant height (cm)	Leaf Length (cm)	Leaf width (cm)	Tillers plant^{-1}	Mother rhizome plant^{-1}	Primary fingers plant^{-1}	Secondary fingers plant^{-1}	Rhizome length (cm)	Rhizome width (cm)	Rhizome weight (g)
R1T1	82.57	59.12	32.80	12.68	3.00	1.93	6.93	6.87	14.76	12.12	126.61
R1T2	82.26	62.49	30.99	10.98	2.67	2.00	6.07	5.73	12.96	12.04	162.56
R1T3	82.22	65.81	35.90	12.60	3.33	2.13	6.33	8.60	13.75	15.51	176.25
R1T4	82.27	61.47	34.26	12.58	2.67	2.33	7.00	8.67	13.25	15.93	170.36
R1T5	90.70	67.80	38.35	14.25	4.03	2.67	7.67	9.07	16.36	16.81	217.01
R1T6	86.67	61.37	32.80	12.92	3.00	2.33	7.63	7.07	13.97	14.96	157.97
R1T7	53.33	56.06	31.99	12.00	2.67	2.27	5.07	5.27	13.40	12.72	124.30
R2T1	88.89	67.02	33.24	11.53	2.60	1.93	4.80	4.60	14.00	14.64	175.66
R2T2	90.67	55.41	32.47	12.76	2.27	2.13	4.87	5.07	12.98	14.11	142.15
R2T3	71.11	61.06	31.51	10.98	2.60	2.20	5.40	5.47	13.48	13.39	180.57
R2T4	80.00	59.28	32.78	11.83	3.33	1.93	5.67	7.40	12.50	13.85	167.12
R2T5	90.44	59.13	32.36	12.73	2.80	2.40	6.53	6.33	11.71	12.62	142.44
R2T6	84.44	59.62	29.49	11.47	3.00	2.00	5.67	7.57	12.76	12.88	121.25
R2T7	51.89	63.11	33.54	11.62	2.47	2.20	6.40	4.53	12.78	12.92	145.69
R3T1	80.00	55.55	28.88	10.23	2.20	2.20	5.73	5.47	11.49	13.99	131.01
R3T2	51.22	51.32	27.58	9.87	1.93	1.47	3.70	3.80	10.42	10.94	97.82
R3T3	82.22	55.27	30.02	13.21	2.53	2.00	4.80	5.73	12.63	13.87	120.35
R3T4	90.56	58.37	30.87	11.33	2.73	2.53	5.73	5.73	14.15	14.51	191.94
R3T5	77.78	52.81	29.82	10.76	2.67	2.00	5.53	7.27	12.36	14.80	152.17
R3T6	84.44	56.55	30.71	10.73	2.27	2.40	4.47	4.73	11.81	14.69	161.03
R3T7	51.56	52.66	28.64	10.23	2.13	1.60	4.07	4.53	11.38	11.32	106.79
R4T1	75.56	60.61	34.51	13.02	3.27	2.13	7.00	7.73	14.53	15.74	208.59
R4T2	75.56	67.03	36.24	13.10	2.87	2.53	7.33	7.13	14.68	14.03	173.38
R4T3	82.22	61.17	38.27	12.95	2.87	2.47	7.33	7.60	12.21	15.59	159.49
R4T4	91.11	70.29	40.14	15.22	4.07	2.73	8.40	10.00	16.63	18.02	219.48
R4T5	84.44	62.75	36.95	14.10	3.47	2.27	6.70	7.07	15.66	15.15	158.83
R4T6	78.89	62.13	38.29	13.21	3.07	2.20	7.60	8.87	14.30	13.85	177.19
R4T7	75.56	67.63	34.28	12.89	2.87	1.93	6.93	7.20	16.22	16.40	199.82
S.Em ±	3.44	2.63	1.31	0.54	0.14	0.15	0.29	0.45	0.73	0.73	11.00
C.D. 5%	9.77	7.47	3.71	1.53	0.38	0.42	0.83	1.29	2.06	2.07	31.20

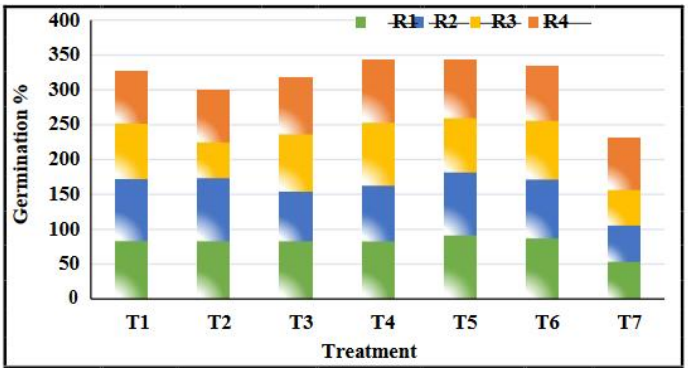

Fig. 1. Mean germination (%) as influenced by rhizome.

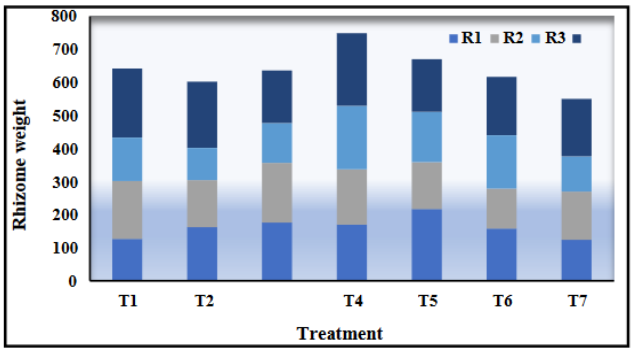

Fig. 2. Mean rhizome weight (g) as influenced by rhizome.

CONCLUSIONS

The study findings indicate that both finger and mother rhizomes produced healthy seedlings, but the mother rhizome outperformed due to its ample food reserves, resulting in vigorous growth and higher yields. Optimal seed root size in specific root crops maximizes solar energy utilization, promoting robust seedling and vegetative development for increased yield. Chilling treatment duration played a crucial role in breaking dormancy and enhancing germination and seedling emergence in turmeric. Notably, using mother rhizomes (R4) and finger rhizomes weighing over 35 g significantly improved various growth characteristics. Similarly, employing Chiller treatment (T4) and 2-hour sodium hypochlorite treatment (4%) positively affected germination percentage and other growth attributes. Thus, pre-sowing rhizome treatments can greatly enhance turmeric crop cultivation.

FUTURE SCOPE

Looking ahead, future research could validate these findings across different turmeric cultivars and growing conditions. Additionally, exploring the scalability and economic feasibility of implementing the identified optimal rhizome size and treatment combination in commercial turmeric cultivation would provide valuable insights for both farmers and the agricultural industry.

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Conflict of Interest. None.

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